REMARKS

Applicants amend claims 1-2, 5, 8, 10-11, cancel claims 4, 6-7, and add claims 12-13. No new matter is added. Hence, claims 1-3, 5, 8-13 are pending, of which claims 1 and 8 are independent. Applicants respectfully submit that the pending claims define over the art of record.

Applicants submit herewith an Information Disclosure Statement regarding art cited in an Office Action issued to the corresponding Japanese patent application. Applicants respectfully note that the amended claims define over the art submitted therewith.

Objection to the Specification

The Examiner objects to the specification for minor informalities. Applicants amend the specification to address the Examiner's concern. Applicants respectfully request that the Examiner reconsider and withdraw the objection to the specification.

Objection to the Claims

The Examiner objects to claims 1-7, and 9-11 for some minor informality. Applicants amend the claims to address the Examiner's concern. Applicants respectfully request that the Examiner reconsider and withdraw the objection to the claims.

Rejection of the Claims under 35 U.S.C. §102

Claims 1, 4-7, and 9-10 are rejected under 35 U.S.C. §102(e) as being anticipated by United States Patent No. 6,833,208 to Kotani et al. (hereafter "Kotani"). Claims 1-2 and 4-10 are rejected under 35 U.S.C. §102(e) as being anticipated by United States Patent No. 6,797,418 to Nomura et al. (hereafter "Nomura").

The Claimed Invention

Independent claim 1 is amended to include the limitation that the reforming air amount control device further controls the supplied amount of the reforming air so as to decrease the supplied amount which was increased by the reforming air amount control device during the warm-up of the reformer when the temperature of the reformer is higher than a first

predetermined temperature which is determined by the regenerating temperature of the reforming catalyst in the reformer. Support for the amendment may be found at least at page 13, line 7 to page 14, line 4 of the present application. The feature of the fuel gas generating apparatus defined in claim 1 is that the supplied amount of the reforming air to the reformer is increased during warm-up of the reformer to promote the activation of the reforming catalyst in the reformer and, therefore, to accelerate the oxidation reaction of the reforming catalyst so as to generate heat. When the temperature reaches the regenerating temperature of the reforming catalyst (the first predetermined temperature), the amount of the reforming air is decreased. Accordingly, the reforming catalyst in the reformer is rapidly activated during the warm-up of the reformer and therefore overheating of the reformer is prevented.

Independent claim 8 is amended to recite that the CO elimination air amount control device further controls the supplied CO amount so as to decrease the supplied amount which was increased by said CO elimination air amount control device during the warm-up of the CO eliminator when the temperature of the CO eliminator is higher than a third predetermined temperature which is determined by the regenerating temperature of the CO eliminating catalyst in the CO eliminator. Support for the amendment may be found at least at page 15, line 10 to page 16, line 6 of the present application. The feature of the fuel gas generating apparatus is that the supplied amount of the CO eliminating air to the CO eliminator is increased during warm-up of the CO eliminator to promote the activation of the CO eliminating catalyst in the CO eliminator and to accelerate the oxidation reaction of the CO eliminating catalyst so as to generate the heat. When the temperature reaches the regenerating temperature of the CO eliminating catalyst (a third predetermined temperature), the amount of the CO eliminating air is decreased. Accordingly, the CO eliminating catalyst in the CO eliminator is rapidly activated during warm-up of the CO eliminator and therefore overheating of the CO eliminator is prevented.

<u>The Kotani Reference</u>

Applicants respectfully submit that the Kotani reference is available as a prior art under 35 U.S.C. §102(e) as of is earliest effective U.S. filing date, November 6, 2001. See MPEP 706.02(f)(1). Applicants submit herewith an English translation of the certified priority

document of the present application, where the certified priority document has a foreign priority filing date of December 22, 2000. Therefore, Applicants respectfully submit that the Kotani reference is not available as prior art. See MPEP 706.02(b). Applicants respectfully request that the Examiner reconsider and withdraw the rejection of the claims over the Kotani reference.

The Nomura Reference

The Nomura reference discloses a fuel processor which drives first and second injecting devices 12 and 13 during the warm-up mode to increase the amount of fuel. The increase of the fuel causes the quantity of water in the water/fuel mixed gas, which is supplied to the vaporizing section, to decrease so that condensation of water vapor can be prevented in a CO removable section. Therefore, the heat quantity required to create the water/fuel mixed gas can be reduced. The heat quantity used to warm the vaporizing section can be therefore incased to permit the time for warming the fuel processor to be shortened.

Nowhere does the Nomura reference disclose the limitation that the reforming air amount control device further controls the supplied amount of the reforming air so as to decrease the supplied amount which was increased by the reforming air amount control device during the warm-up of the reformer when the temperature of the reformer is higher than a first predetermined temperature which is determined by the regenerating temperature of the reforming catalyst in the reformer, as required by independent claim 1. The Nomura reference also does not disclose the limitation that the CO elimination air amount control device further controls the supplied amount of the CO eliminating air so as to decrease the supplied amount which was increased by said CO elimination air amount control device during the warm-up of the CO eliminator when the temperature of the CO eliminator is higher than a third predetermined temperature which is determined by the regenerating temperature of the CO eliminating catalyst in the CO eliminator, as required by independent claim 8.

Therefore, Applicants respectfully submit that the Nomura reference does not teach or suggest each and every element and limitation in independent claim 1 or 8. Accordingly, Applicants respectfully request that the Examiner reconsider and withdraw the rejection of claims 1-2 and 4-10 over the Nomura reference.

Rejection of Claims under 35 U.S.C. §103

Claim 3 is rejected under 35 U.S.C. §103(a) as being obvious over the Nomura reference. Claim 11 is rejected under 35 U.S.C. §103(a) as being obvious over the Nomura reference in view of United States Patent No. 4,693,882 to Setzer et al. (hereafter "Setzer"). Claim 8 is rejected under 35 U.S.C. §103(a) as being obvious the Kotani reference. Claim 11 is rejected under 35 U.S.C. §103(a) as being obvious over the Kotani reference in view of the Setzer reference.

The Kotani Reference

As set forth above, the Kotani reference is not available as a prior art, therefore Applicants respectfully submit that the rejection of claims 8 and 11 under 35 U.S.C. §103(a) over the Kotani reference is moot. Applicants respectfully request that the Examiner reconsider and withdraw the rejection of claims 8 and 11.

The Nomura Reference

As set forth above, the Nomura reference does not disclose or suggest each and every element and limitation of independent claims 1 and 8. There is no motivation to modify the Nomura reference to achieve the claimed invention. The Nomura reference shortens the time for warming the fuel processor by indirectly *decreasing the amount of water* supplied to the vaporizing section so that less heat is needed to warm up the water/fuel mixed gas, whereas the claimed invention shortens the time for warm-up of the reformer by *increasing the amount of reforming air*. Additionally, nowhere does the Nomura reference suggest that a reforming air may be used with the vaporizing section in the Nomura reference. Therefore, independent claims 1 and 8 are not obvious in view of the Nomura reference.

The Setzer Reference

The Examiner cites the Setzer reference to show that the reformer catalyst can be a palladium-type previous metal catalyst. However, the Setzer reference does not teach or suggest the limitation that the reforming air amount control device further controls the supplied amount of the reforming air so as to decrease the supplied amount which was increased by the reforming

air amount control device during the warm-up of the reformer when the temperature of the reformer is higher than a first predetermined temperature which is determined by the regenerating temperature of the reforming catalyst in the reformer, as required by independent claim 1. The Setzer reference also does not teach or suggest the limitation that the CO elimination air amount control device further controls the supplied amount of the CO eliminating air so as to decrease the supplied amount which was increased by said CO elimination air amount control device during the warm-up of the CO eliminator when the temperature of the CO eliminator is higher than a third predetermined temperature which is determined by the regenerating temperature of the CO eliminating catalyst in the CO eliminator, as required by independent claim 8.

Therefore, the combination of the Nomura reference and the Setzer reference does not teach or suggest all the element and limitation of independent claims 1 and 8. Applicants note that the dependent claims also recite separate patentable subject matter. As such, for this and the reasons set forth above, Applicants respectfully submit that the dependent claims also define over the art of record.

New Claim

Applicants add new claims 12 and 13. Claim 12 depends from independent claim 1 and claim 13 depends from independent claim 8. As set forth above, claims 1 and 8 define over the art of record. Applicants note that claims 12 and 13 also recite separate patentable subject matter. As such, for this and the reasons set forth above, claims 12 and 13 also define over the art of record.

Double Patenting Rejection

Claims 1-10 are rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-12 of the Nomura reference. Claim 11 is rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-12 of the Nomura reference in view of the Setzer reference. Claims 1 and 4-10 are rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-10 of the Kotani reference. Claim 11 is rejected under the judicially

created doctrine of obviousness-type double patenting as being unpatentable over claims 1-10 of the Kotani reference over the Setzer reference.

Applicants respectfully submit that independent claims 1 and 8 have been amended to include additional limitations and that the additional limitations are not rendered obvious in view of the Nomura reference, the Kotani reference, and the Setzer reference. Applicants respectfully request that the Examiner reconsider and withdraw the rejection of obviousness-type double patenting rejection.

CONCLUSION

In view of the above amendment, applicant believes the pending application is in condition for allowance.

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Attachment

example, the reformer 11 in the embodiment described below) that generates a reforming gas that includes hydrogen from the raw fuel gas that has been partially oxidized by adding reforming air to the fuel vapor generated by the vaporizer, and a CO eliminator (for example, the CO eliminator 13 in the embodiment described below) that generates a fuel gas having carbon monoxide eliminated by adding a CO eliminating air to the reforming gas generated by the autothermal reformer, comprising: a reforming air amount control device ~~(for example, step S 112 in the embodiment described below)~~ that controls the supplied amount of the reforming air during the warm-up of the reformer so as to become larger than the supplied amount of reforming air during the idle operation after completion of the warm-up.

Due to having this type of structure, oxygen in the air supplied in excess to the reformer during warm-up ~~is combusted~~facilitates the combustion by a catalyst inside the reformer, and this combustion heat heats the reformer and the reforming gas. In addition, the CO eliminator and the gas path in the system are heated by the heated reforming gas flowing downstream.

A second aspect of the present invention ~~according to the first aspect~~ is characterized in comprising a fuel amount control device ~~(for example, step S 112 in the embodiment described below)~~ that controls the supplied amount of the raw liquid fuel during the warm-up of the reformer so as to become larger than the supplied amount of raw liquid fuel during idle operation after completion of the warm-up.

Due to having this type of structure, the amount of heat generation in the reformer during warm-up is increased further, and at the same time the amounts of hydrogen, CO, and unreacted hydrocarbons flowing out from the reformer during warm-up is increased.

A third aspect of the present invention ~~according to the second aspect~~ is characterized in that the ratio of the increased supplied amount of reformed air controlled by the reforming air amount control device is set larger than the ratio of the increased supplied amount of raw liquid fuel controlled by the fuel amount control device. Due to having this type of structure, the amount of oxygen that allows combustion in the catalyst in the reformer can be guaranteed.

A fourth aspect of the present invention ~~according to any of the first through third aspects~~ is characterized in that the temperature corresponding to the warm-up state of the reformer is detected, and when this detected temperature has become higher than a

example, the reformer 11 in the embodiment described below) that generates a reforming gas that includes hydrogen from the raw fuel gas that has been partially oxidized by adding reforming air to the fuel vapor generated by the vaporizer, and a CO eliminator (for example, the CO eliminator 13 in the embodiment described below) that generates a fuel gas having carbon monoxide eliminated by adding a CO eliminating air to the reforming gas generated by the autothermal reformer, comprising: a reforming air amount control device that controls the supplied amount of the reforming air during the warm-up of the reformer so as to become larger than the supplied amount of reforming air during the idle operation after completion of the warm-up.

Due to having this type of structure, oxygen in the air supplied in excess to the reformer during warm-up facilitates the combustion by a catalyst inside the reformer, and this combustion heat heats the reformer and the reforming gas. In addition, the CO eliminator and the gas path in the system are heated by the heated reforming gas flowing downstream.

A second aspect of the present invention is characterized in comprising a fuel amount control device that controls the supplied amount of the raw liquid fuel during the warm-up of the reformer so as to become larger than the supplied amount of raw liquid fuel during idle operation after completion of the warm-up.

Due to having this type of structure, the amount of heat generation in the reformer during warm-up is increased further, and at the same time the amounts of hydrogen, CO, and unreacted hydrocarbons flowing out from the reformer during warm-up is increased.

A third aspect of the present invention is characterized in that the ratio of the increased supplied amount of reformed air controlled by the reforming air amount control device is set larger than the ratio of the increased supplied amount of raw liquid fuel controlled by the fuel amount control device. Due to having this type of structure, the amount of oxygen that allows combustion in the catalyst in the reformer can be guaranteed.

A fourth aspect of the present invention is characterized in that the temperature corresponding to the warm-up state of the reformer is detected, and when this detected temperature has become higher than a

predetermined temperature, the supplied amount of reforming air that is increased by the reforming air amount control device during the warm-up of the reformer is then decreased. Due to having this type of structure, the overheating of the catalyst in the reformer can be prevented.

A fifth aspect of the present invention ~~according to the fourth aspect~~ is characterized in that the control for decreasing the supplied amount of the reforming air is decreased depending on the detected temperature. Due to having this type of structure, the warm-up state of the reformer can be gradually stabilized.

A sixth and seventh aspect of the present invention ~~respectively according to the fourth and fifth aspects~~ is characterized in that the detected temperature is at least one among the temperature of the catalyst in the reformer, the temperature of the reforming gas, or the temperature of the case of the reformer. Due to having this type of structure, when the reformer has been warmed-up as required, the supplied amount of reforming air that has been increased by compensation can be controlled so as to be reduced, and the overheating of the catalyst in the reformer can be reliably prevented. Moreover, because there is "at least one", any one among the temperature of the catalyst in the reformer, the temperature of the reforming gas, or the temperature of the case of the reformer can be used, or the one among these temperatures that is the lowest can be used, or the one among these that is the highest can be used.

An eighth aspect of the present invention is characterized in comprising a fuel gas generating apparatus for a fuel cell (for example, the fuel gas generating apparatus 1 in the embodiment described below) comprising a vaporizer (for example, the vaporizer 22 in the embodiment described below) that generates a fuel vapor by vaporizing a raw liquid fuel, an autothermal reformer (for example, the reformer 11 in the embodiment described below) that generates a reforming gas that includes hydrogen from the raw fuel gas that has been partially oxidized by adding reforming air to the fuel vapor generated by the vaporizer, and a CO eliminator (the CO eliminator 13 in the embodiment described below) that generates a fuel gas having carbon monoxide eliminated by adding a CO eliminating air to the reforming gas generated by the autothermal reformer, comprising: a CO eliminating air amount control device ~~(for example, step S 112 in the embodiment described above)~~ that controls the supplied amount of CO eliminating air during the warm-up of the CO eliminator so as to become larger than the supplied amount of CO eliminating air during the idle operation after

predetermined temperature, the supplied amount of reforming air that is increased by the reforming air amount control device during the warm-up of the reformer is then decreased. Due to having this type of structure, the overheating of the catalyst in the reformer can be prevented.

A fifth aspect of the present invention is characterized in that the control for decreasing the supplied amount of the reforming air is decreased depending on the detected temperature. Due to having this type of structure, the warm-up state of the reformer can be gradually stabilized.

A sixth and seventh aspect of the present invention is characterized in that the detected temperature is at least one among the temperature of the catalyst in the reformer, the temperature of the reforming gas, or the temperature of the case of the reformer. Due to having this type of structure, when the reformer has been warmed-up as required, the supplied amount of reforming air that has been increased by compensation can be controlled so as to be reduced, and the overheating of the catalyst in the reformer can be reliably prevented. Moreover, because there is "at least one", any one among the temperature of the catalyst in the reformer, the temperature of the reforming gas, or the temperature of the case of the reformer can be used, or the one among these temperatures that is the lowest can be used, or the one among these that is the highest can be used.

An eighth aspect of the present invention is characterized in comprising a fuel gas generating apparatus for a fuel cell (for example, the fuel gas generating apparatus 1 in the embodiment described below) comprising a vaporizer (for example, the vaporizer 22 in the embodiment described below) that generates a fuel vapor by vaporizing a raw liquid fuel, an autothermal reformer (for example, the reformer 11 in the embodiment described below) that generates a reforming gas that includes hydrogen from the raw fuel gas that has been partially oxidized by adding reforming air to the fuel vapor generated by the vaporizer, and a CO eliminator (the CO eliminator 13 in the embodiment described below) that generates a fuel gas having carbon monoxide eliminated by adding a CO eliminating air to the reforming gas generated by the autothermal reformer, comprising: a CO eliminating air amount control device that controls the supplied amount of CO eliminating air during the warm-up of the CO eliminator so as to become larger than the supplied amount of CO eliminating air during the idle operation after

completion of the warm-up.

Due to having this type of structure, the hydrogen, the carbon monoxide, and the unreacted hydrocarbons flowing out from the reformer during warm-up are sufficiently combusted by the catalyst in the CO eliminator, ~~along~~ owing to with the oxygen in the CO eliminating air that is supplied in excess, and the CO eliminator can be heated by this combustion heat. Furthermore, the gas path in the system can be heated due to this combustion gas flowing downstream.

An ninth aspect of the present invention is characterized in that the autothermal reformer and CO eliminator supply the fuel gas to the fuel cell after it has been determined that the warm-up has completed. Due to having this type of structure, a fuel gas that has been controlled so as to obtain a predetermined gas composition and gas temperature can be supplied to the fuel cell.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a drawing showing the schematic structure of the first embodiment of the fuel gas generating apparatus for a fuel cell according to the present invention.

Fig. 2 is a flowchart (one of two) of the warm-up processing for the fuel gas generating apparatus.

Fig. 3 is a flowchart (two of two) of the warm-up processing for the fuel gas generating apparatus.

Figs. 4A to 4C are maps for calculating the amount of fuel and the amount of air supplied to the start-up burner in the fuel gas generating apparatus.

Figs. 5A to 5F are maps for calculating the initially supplied amounts of raw fuel, reforming air, and CO eliminating air in the fuel gas generating apparatus.

Figs. 6A to 6C are maps for calculating the supplied amount of raw fuel and reforming air when carrying out F/B (feedback) control of the reforming catalyst temperature in the fuel gas generating apparatus.

Figs. 7A to 7C are maps for calculating the supplied amount of CO eliminating air when carrying out F/B (feedback) control of the CO eliminating catalyst temperature in the fuel gas generating apparatus.

Fig. 8 is a drawing showing the change in the amount of supplied reforming air and the amount of supplied fuel vapor with the passage of time from the beginning of the operation.

completion of the warm-up.

Due to having this type of structure, the hydrogen, the carbon monoxide, and the unreacted hydrocarbons flowing out from the reformer during warm-up are sufficiently combusted by the catalyst in the CO eliminator, owing to with the oxygen in the CO eliminating air that is supplied in excess, and the CO eliminator can be heated by this combustion heat. Furthermore, the gas path in the system can be heated due to this combustion gas flowing downstream.

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Figs. 6A to 6C are maps for calculating the supplied amount of raw fuel and reforming air when carrying out F/B (feedback) control of the reforming catalyst temperature in the fuel gas generating apparatus.

Figs. 7A to 7C are maps for calculating the supplied amount of CO eliminating air when carrying out F/B (feedback) control of the CO eliminating catalyst temperature in the fuel gas generating apparatus.

Fig. 8 is a drawing showing the change in the amount of supplied reforming air and the amount of supplied fuel vapor with the passage of time from the beginning of the operation.

Fig. 9 is a drawing showing the change in the amount of heat generated in the reforming reactor with the passage of time from the beginning of the operation.

Fig. 10 is a drawing showing the change in the amount of supplied CO eliminating air with the passage of time from the beginning of the operation.

Figs. 11A to 11D are drawings showing the change in the reforming catalyst temperature, the CO eliminating catalyst temperature, ~~and the wall surface temperature~~the wall surface temperature, and the CO concentration and THC concentration in the fuel gas with the passage of time from the beginning of the operation.

DETAILED DESCRIPTION OF THE INVENTION

Below, an embodiment of the gas fuel generating apparatus for a fuel cell according to the present invention will be explained while referring to Fig. 1 through Fig. 11. Moreover, the embodiment explained below is a form of the fuel gas generating apparatus for a fuel cell that is mounted in a fuel cell vehicle.

Fig. 1 is a schematic drawing of the fuel gas generating apparatus for a fuel cell (below, abbreviated "fuel gas generating apparatus"), and the fuel gas generating apparatus 1 provides a reforming reactor 10, a fuel cell stack (fuel cell) 21, and a vaporizer 22 as essential elements, and the reforming reactor 10 provides a reformer 11, a heat exchanger 12, a CO eliminator 13, and a start-up burner 14.

The fuel cell stack 21 is a solid polymer-type fuel cell, and generates electricity by causing an electrochemical reaction between the hydrogen in the fuel gas supplied to the anode electrode and the oxygen in the air, which serves as an oxidizing agent, supplied to the cathode cell.

The fuel gas supplied to the anode electrode of the fuel cell stack 21 that is used is a raw liquid fuel that has been vaporized by a vaporizer 22, and then reformed into a hydrogen rich fuel gas by a reforming reactor 10.

Furthermore, the raw liquid fuel for reforming, which comprises a hydrocarbon fuel (for example, methanol) and water mixed at a predetermined ratio, and the air for reforming (below, referred to as the "reforming air") are supplied to the vaporizer 22; the raw liquid fuel and the reforming air in the vaporizer 22 are heated; and the raw liquid fuel becomes fuel vapor by being vaporized and is supplied to the reformer 11 of the reforming reactor 10 via the fuel supply duct 31 from the vaporizer 22 in a state mixed with the heated reforming air.

The reformer 11 of the reforming reactor 10 is an autothermal reformer

Fig. 9 is a drawing showing the change in the amount of heat generated in the reforming reactor with the passage of time from the beginning of the operation.

Fig. 10 is a drawing showing the change in the amount of supplied CO eliminating air with the passage of time from the beginning of the operation.

Figs. 11A to 11D are drawings showing the change in the reforming catalyst temperature, the CO eliminating catalyst temperature, the wall surface temperature, and the CO concentration and THC concentration in the fuel gas with the passage of time from the beginning of the operation.

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Furthermore, the raw liquid fuel for reforming, which comprises a hydrocarbon fuel (for example, methanol) and water mixed at a predetermined ratio, and the air for reforming (below, referred to as the "reforming air") are supplied to the vaporizer 22; the raw liquid fuel and the reforming air in the vaporizer 22 are heated; and the raw liquid fuel becomes fuel vapor by being vaporized and is supplied to the reformer 11 of the reforming reactor 10 via the fuel supply duct 31 from the vaporizer 22 in a state mixed with the heated reforming air.

The reformer 11 of the reforming reactor 10 is an autothermal reformer